Lung ultrasound:
an update on disease detection in dairy calves

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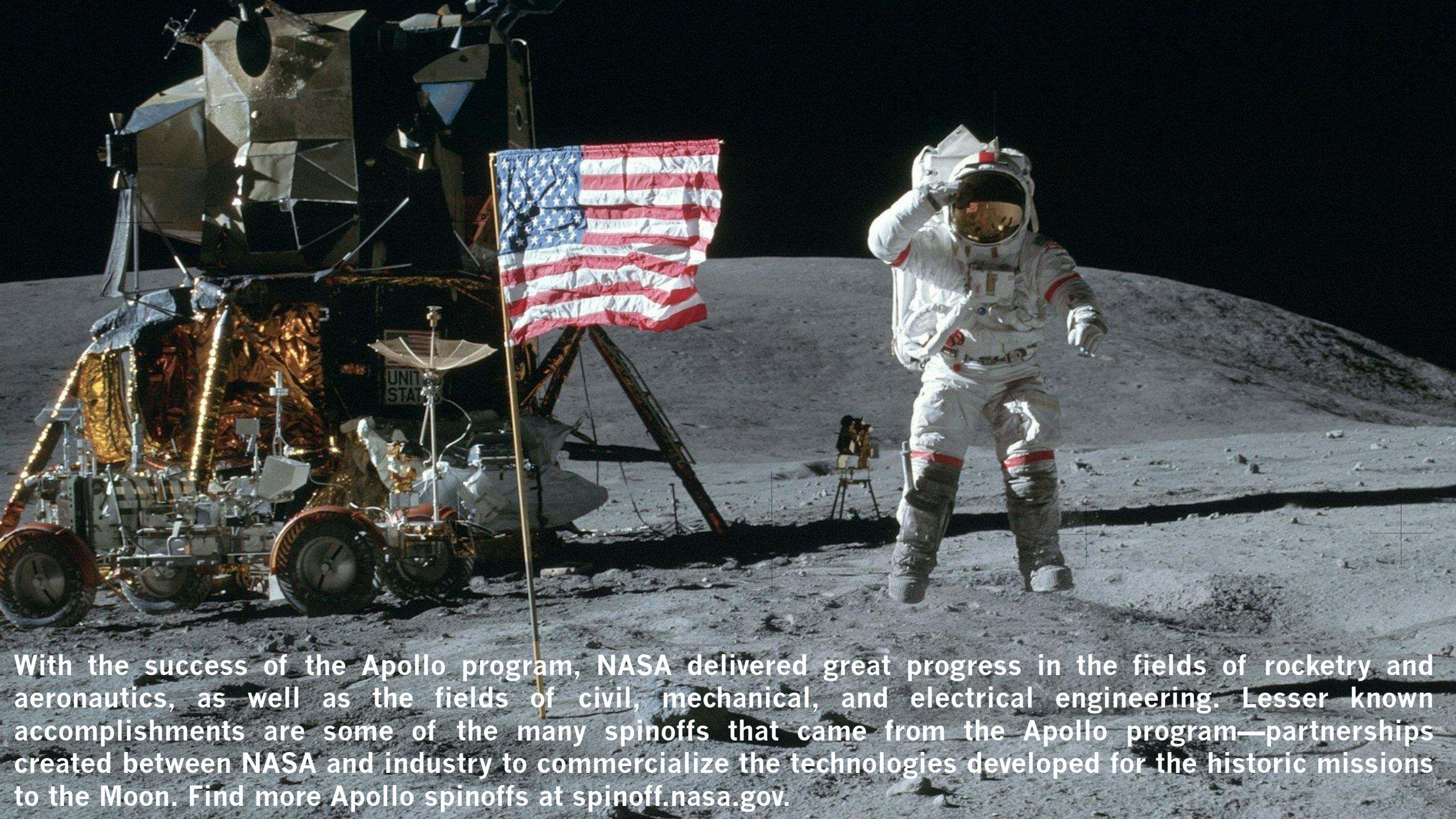
What we knew in 2019 – dairy calves

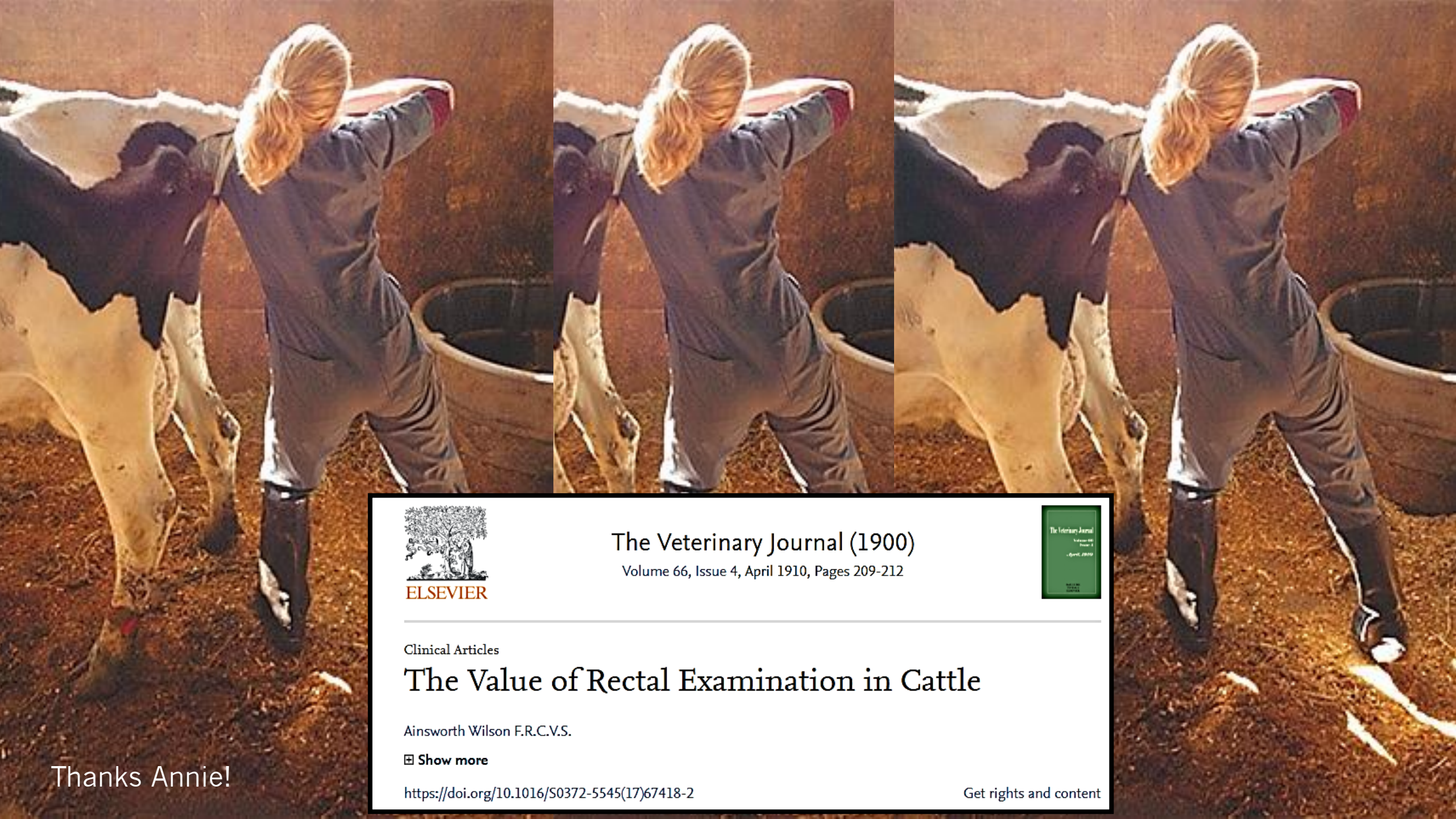
- **Fast –** scan up to 30 calves/h in individual housing
- **Sensitive** (>88%) (Ollivett et al., 2015)
  - Clinical exam (60-70%) or auscultation (<10%) (Buczinski et al., 2014)
- **Associated with short term outcomes**
  - **Growth** (Binversie et al., 2017; Cramer et al., 2019)
  - **Vaccine, antibiotic response** (Ollivett et al., 2018; Holschbach et al., 2019)
- **Associated with long term outcomes**
  - **Death** (Adams and Buczinski, 2016)
  - **Removal and decreased pregnancy risk** (Teixeria et al., 2017)
  - **Decreased milk production (525 kg first lactation 305ME)** (Dunn et al., 2018)
- **Resolution of disease following treatment** – not guaranteed (Binversie et al., 2017; Holschbach et al., 2019;)
- **Attitude scores and Feeding behavior** – associated with clinical pneumonia not subclinical pneumonia (Cramer et al., 2019)

What I heard at BRDS 2019…

- BRD is BAD, now AND later in life…
- Producer records lack quality and quantity…
- Clinical exam/scoring is not sensitive…
- We need to go back to the basics…
- We need to focus on the host/environment not the bug…
- If it pays in the long run, producers will make it work…
- We need to do something different…
- We aren’t where we need to be…



With the success of the Apollo program, NASA delivered great progress in the fields of rocketry and aeronautics, as well as the fields of civil, mechanical, and electrical engineering. Lesser known accomplishments are some of the many spinoffs that came from the Apollo program—partnerships created between NASA and industry to commercialize the technologies developed for the historic missions to the Moon. Find more Apollo spinoffs at spinoff.nasa.gov.



ELSEVIER

The Veterinary Journal (1900)
Volume 66, Issue 4, April 1910, Pages 209-212

Clinical Articles

The Value of Rectal Examination in Cattle

Ainsworth Wilson F.R.C.V.S.

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https://doi.org/10.1016/S0372-5545(17)67418-2

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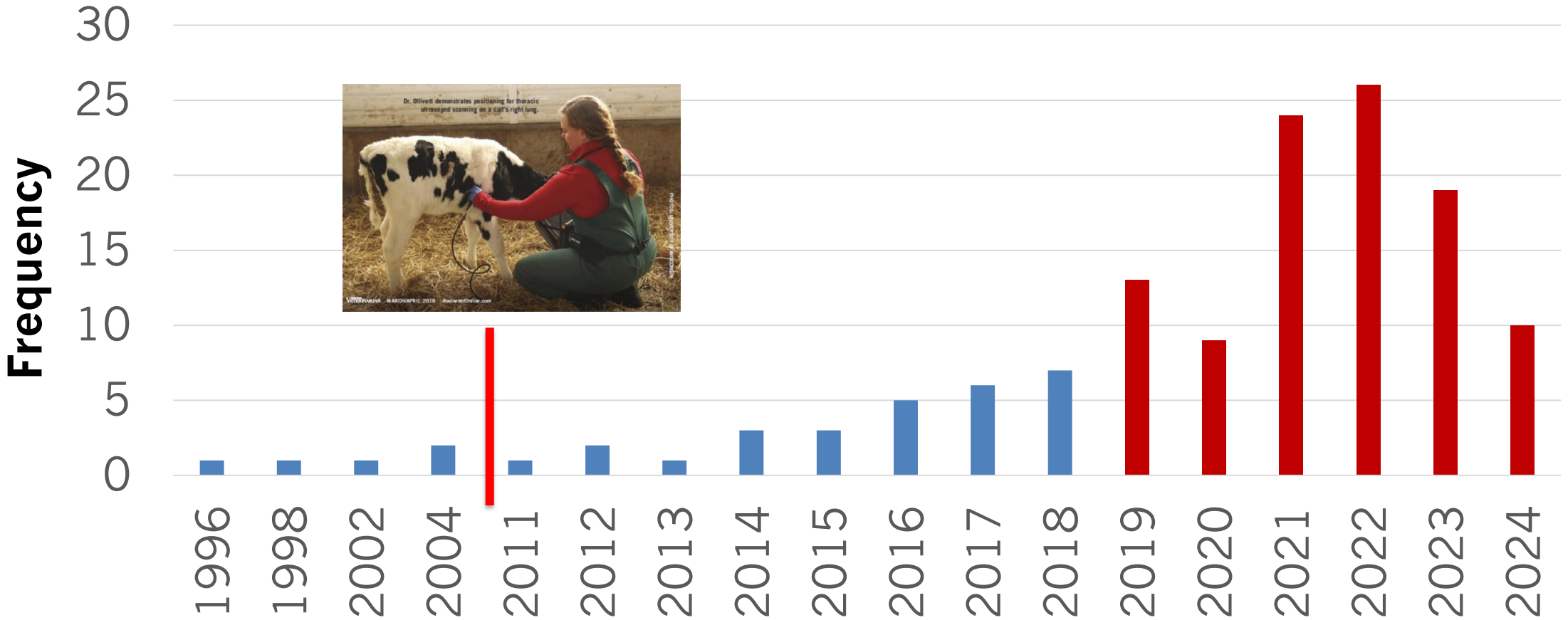
Thanks Annie!

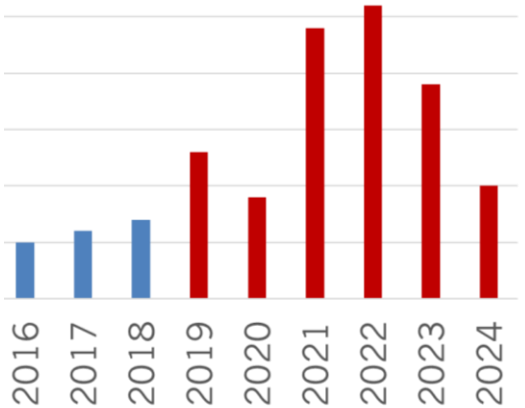
Dairy Publications 1996 - 2024
n = 134



n = 95, 2019 - 2024

Momentum growing in research but…

- Inconsistent definitions of "positive" lung ultrasound
  - Cut-points: ≥ 1cm^2, ≥ 3cm^2
  - Lobular versus lobar: lesion size (cm^2) or lesion distribution (Ollivett)
- Inconsistent definitions of "positive clinical disease"
  - WI score cut-points ≥ 4; ≥ 5
  - WI score 2 or more categories scoring 2 or more (Ollivett)
  - CA score
  - Individual clinical abnormalities (cough, nasal discharge, etc)



- Existing cases of disease versus new cases of disease
  - Single observation versus multiple observations (cross-sectional vs cohort)
- Inconsistent technique & terminology: lung ultrasound, TUS, qTUS, FLUS
- Heavy focus on bugs, drugs, and vaccines

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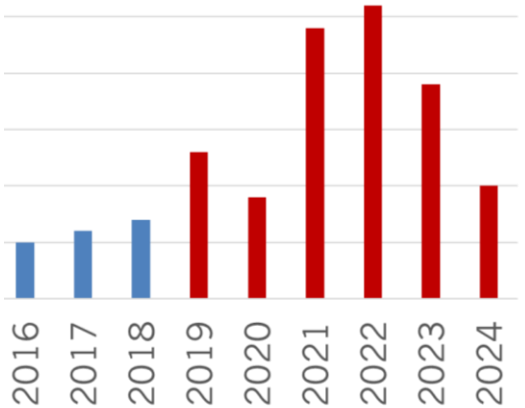

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Momentum growing in research but…

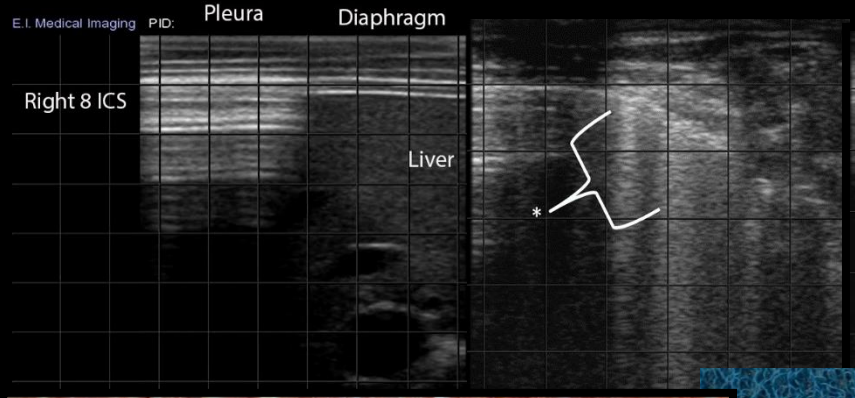
- **Definitions of "positive" lung ultrasound**
  - Quick to apply calf-side – no recording of loops, no mental math required
    - Provide a mental estimate of the amount of lung parenchyma affected
    - Provide severity levels to measure better or worse at follow up scans
  - Have biologically relevant cut-point
    - ≥ 3cm^2 - **Dunn et al., 2018:**
    - ≥ 1cm^2 – **Cramer et al., 2019:**
  - Lobular versus lobar:
    - lesion size (cm^2)
    - lesion distribution (Ollivett)

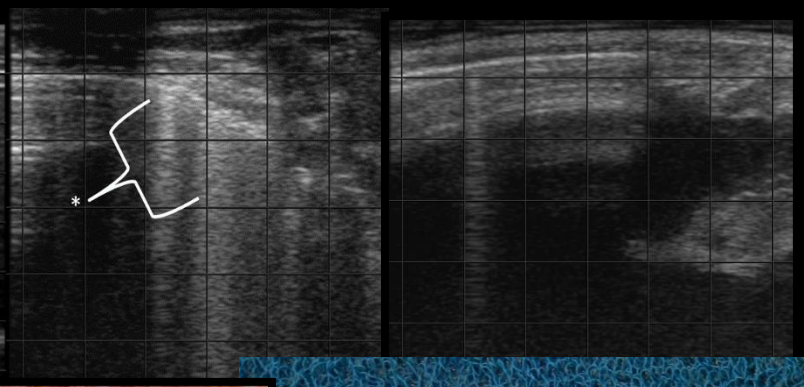
Dunn: The cutoff of **3 cm** was determined by selecting the value between the 90th and 95th percentiles of ultrasound consolidation in calves with any amount of consolidation in their first ultrasound examination **(ARBITRARY)**

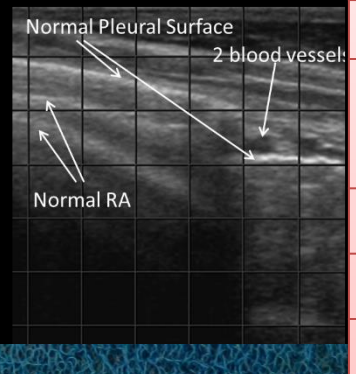
Cramer: Calves with **1 cm** had lower ADG than calves without lung consolidation (n = 64; 0.73 vs. 0.85 kg/d, P = 0.01) **(IMPACT)**

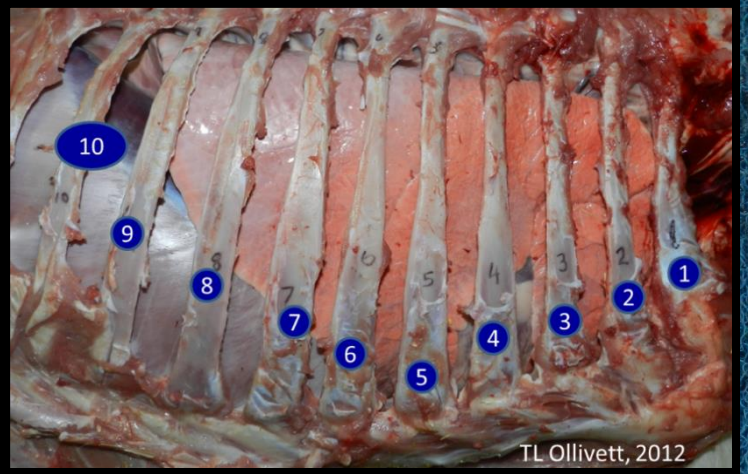
- **If our goal is to detect disease as early as possible, cut-points should be biased to the low end and still have measureable effect on the calf**

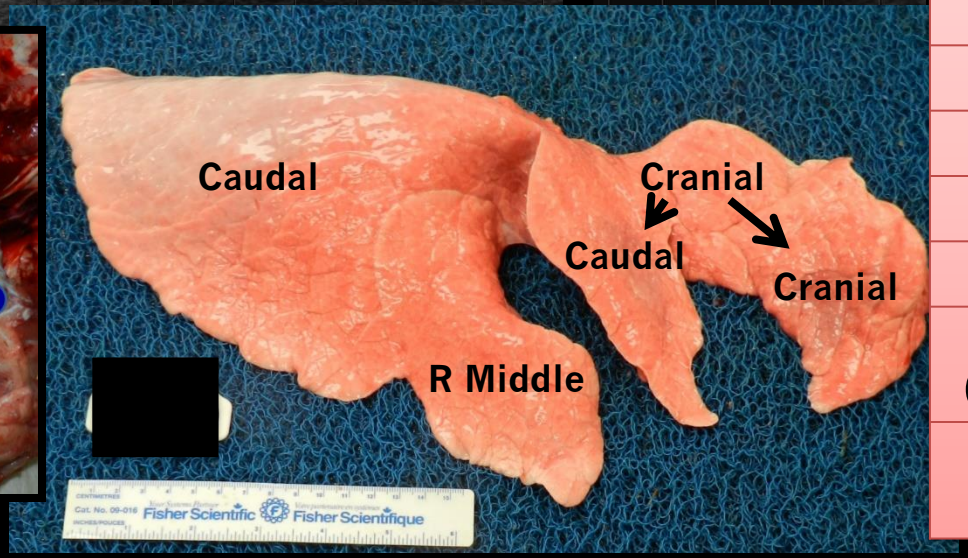
Calf Lung Ultrasound











RCrCr = right cranial cranial lobe

Age (d)	USS2+	RCrCr+	RCrCr Only
10 – 14	32%	92%	50%
15 – 18	34%	93%	64%
19 – 22	39%	95%	60%
23 – 26	48%	97%	69%
27 – 30	47%	96%	60%
31 – 35	48%	98%	63%
36 – 70	55%	96%	56%
Overall	**42%**	**95%**	**61%**

N = 2311 scans

https://thedairylandinitiative.vetmed.wisc.edu/home/calf-health-module/

Severe bronchopneumonia

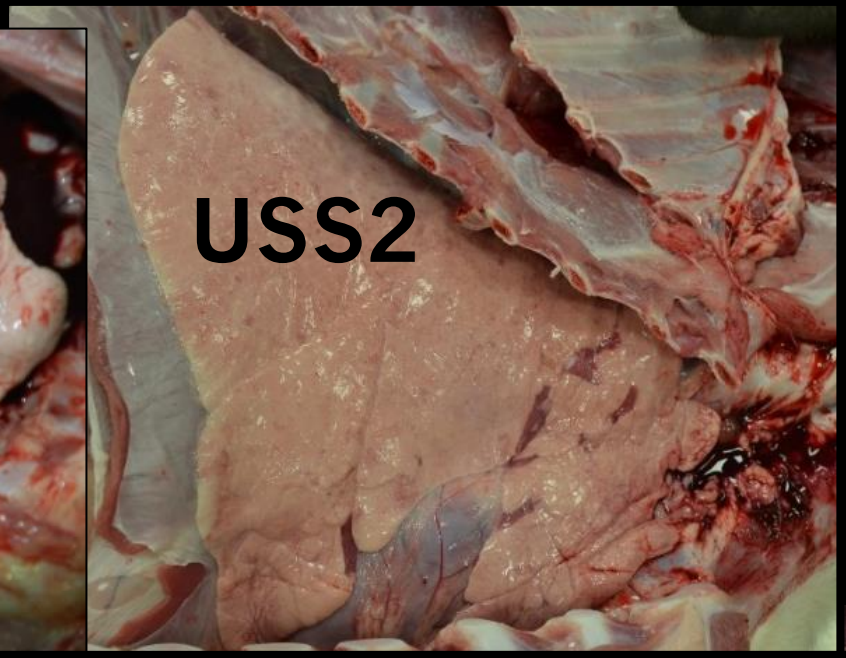
Normal lung

Momentum growing in research but…

- **Existing cases** of disease versus **new cases** of disease
  - Single observation versus multiple observations (cross-sectional vs cohort)

- **Goal – move to the bar**
  - Fewer calves affected
  - More cures
  - Faster treatment response times

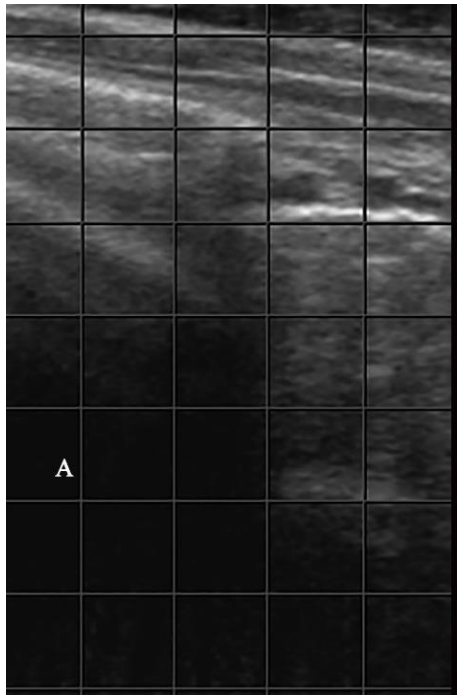
- Need "cases" to be early in the course of disease
  - **Existing cases can be days to weeks old at diagnosis in cross-sectional studies**
  - **Consolidation in clinical cases typically weeks old in uncomplicated *Pasteurella/Mycoplasma* endemic pneumonia herds**

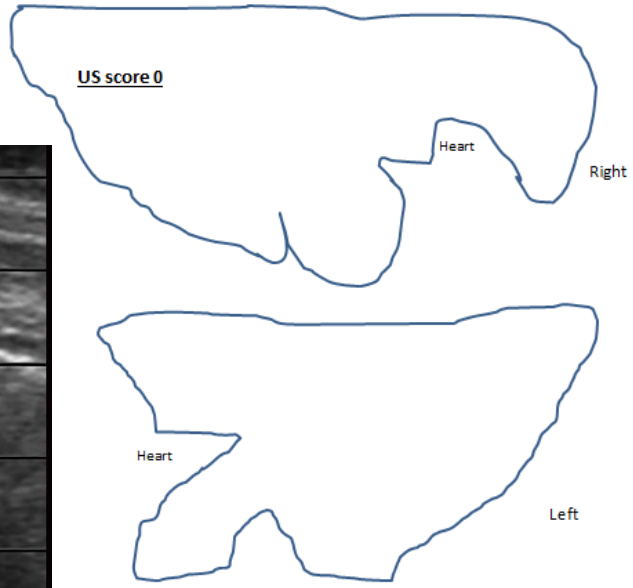


Lung ultrasound	Se > 88% Sp > 90%

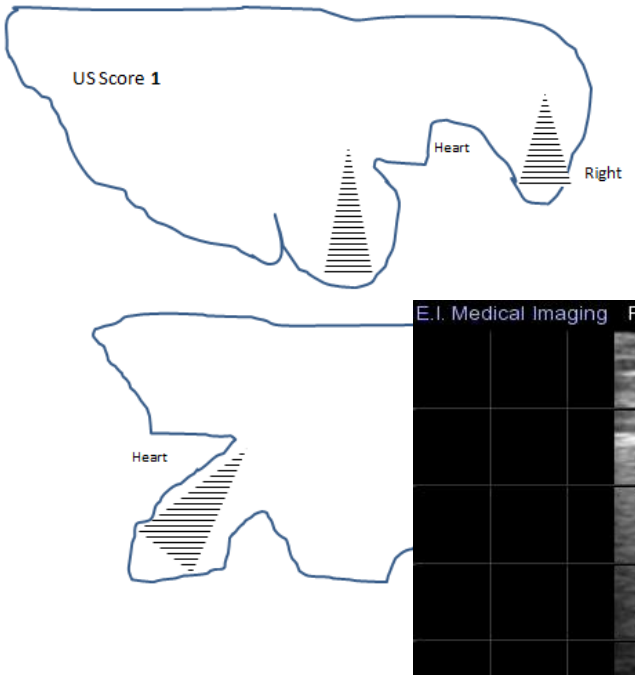
0 – 5 TUS scoring system

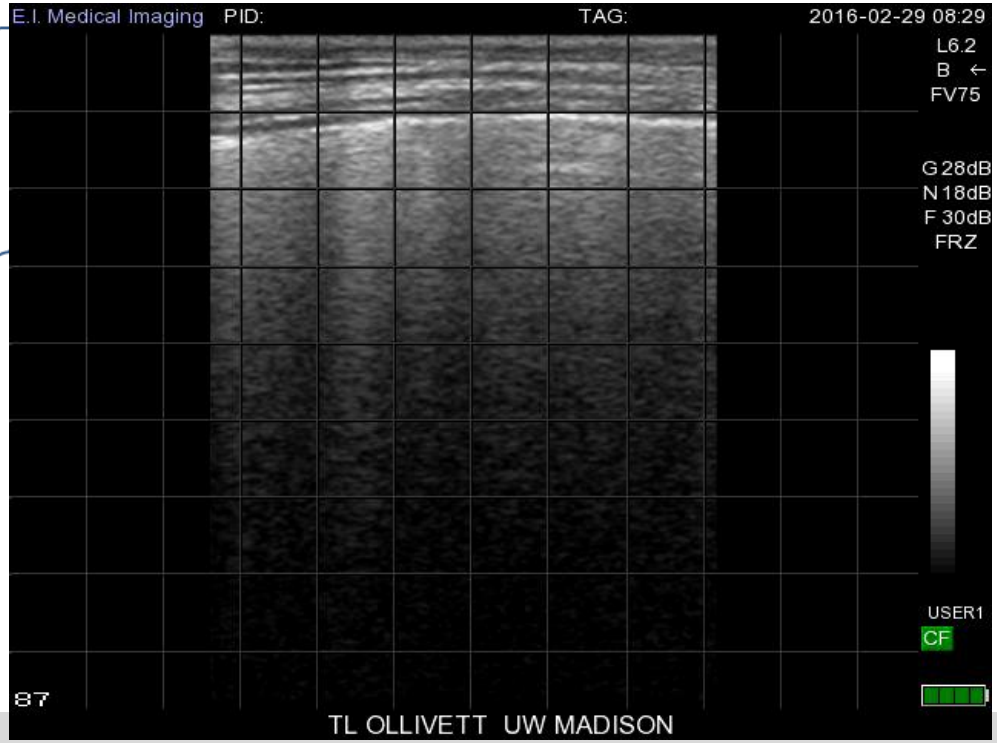
0 = normal



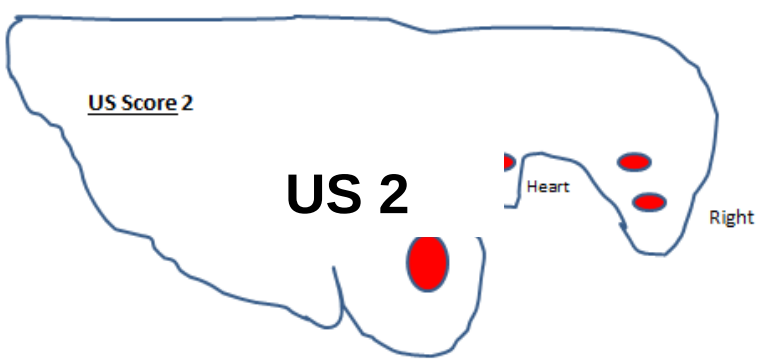


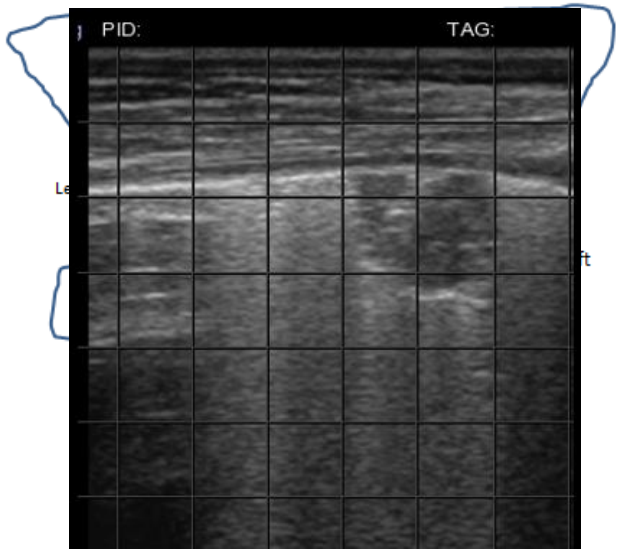
1 = interstitial

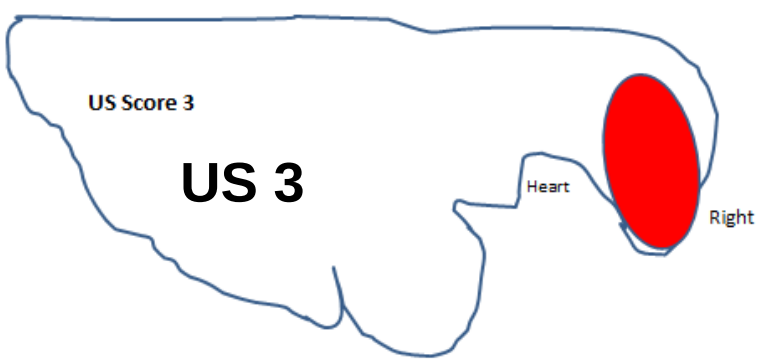


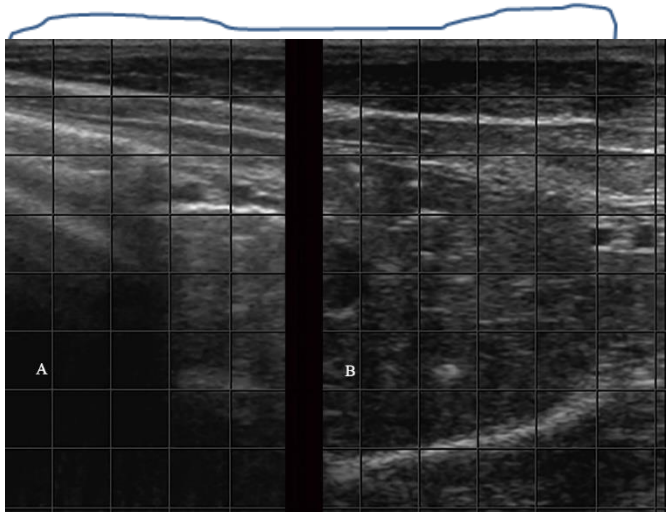


2 = **lobular** pneumonia
3 = **lobar** pneumonia **1 lobe**

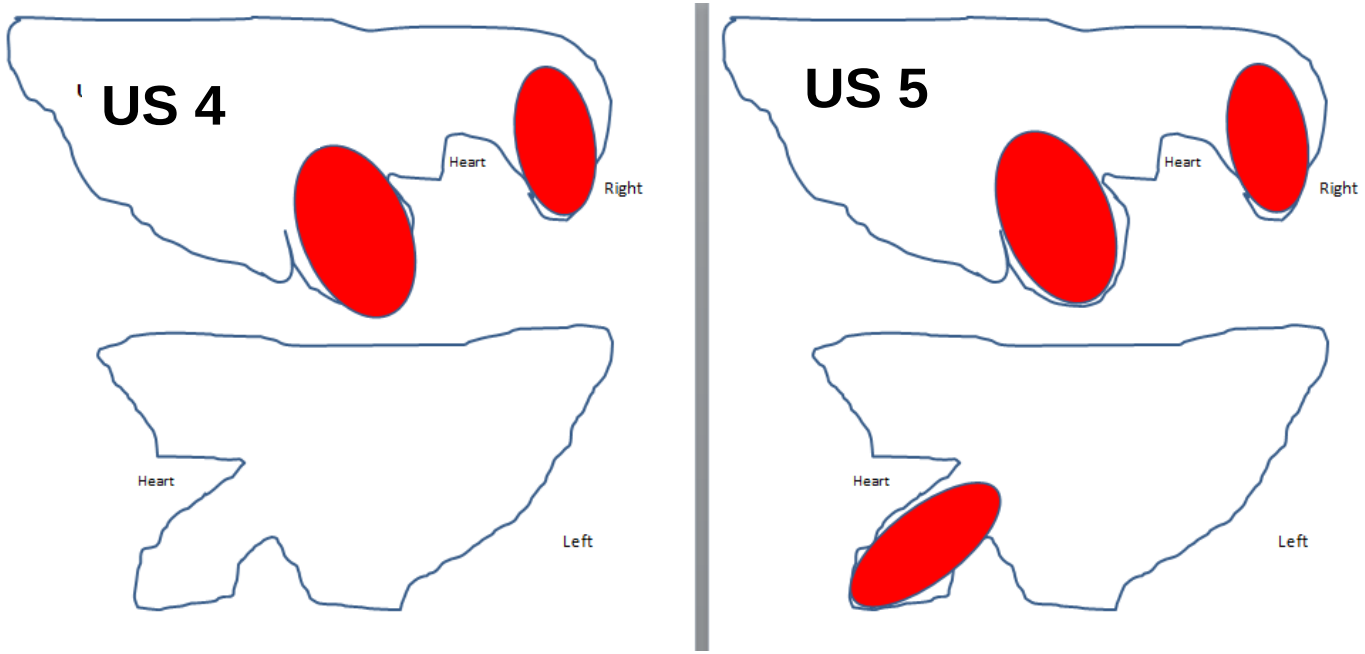








4 = **lobar** pneumonia **2 lobes**
5 = **lobar** pneumonia **3 + lobes**



“Lungs are the window to calf health management”

Indicator organ

respiratory disease is a symptom of management failure

Got failure of passive transfer → see it in the lungs
Got diarrhea → see it in the lungs
Got septicemia → see it in the lungs
Got poor nutrition → see it in the lungs
Got dirty environment → see in the lungs
Got cold stress → see it in the lungs
Got heat stress → see it in the lungs

Stop the research focus on bugs & drugs:

Focus on genetic contributors and figuring out how to manage people and facilities differently to reduce the incidence of disease

Momentum on farm:

Lung ultrasound leaders - OG

Dr. Liz Cox

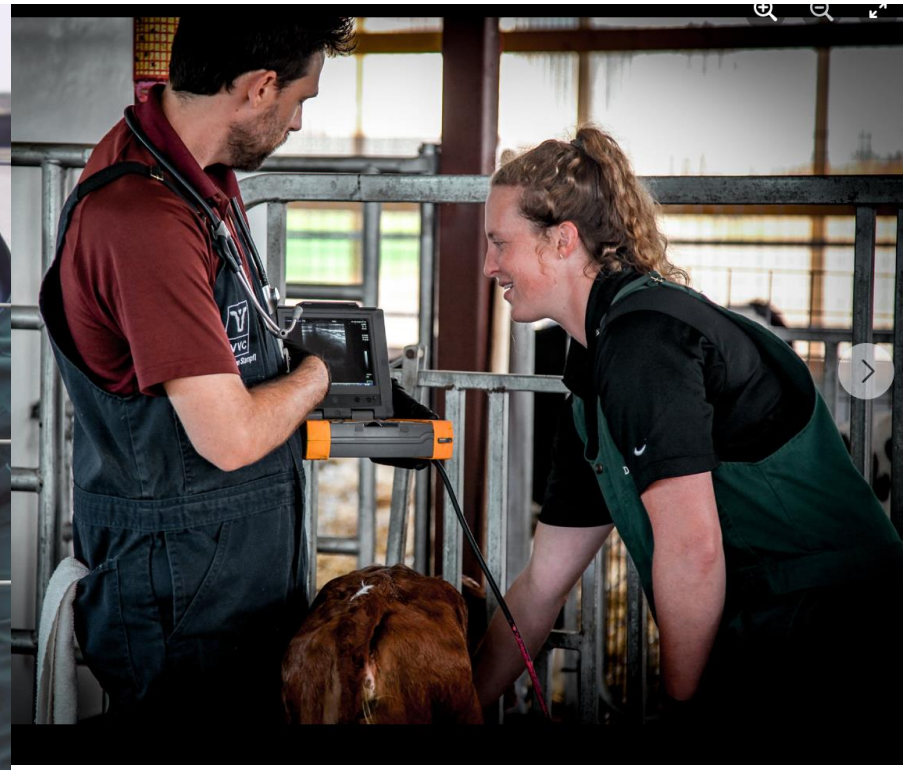
Dr. Sébastien Buczinski

Dr. Terri Ollivett

Dr. Sam Barringer

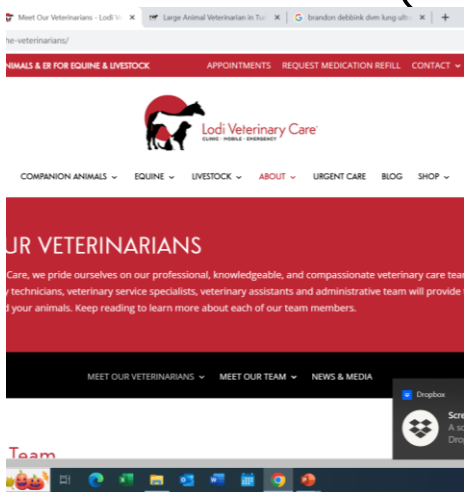
Lung ultrasound leaders - New

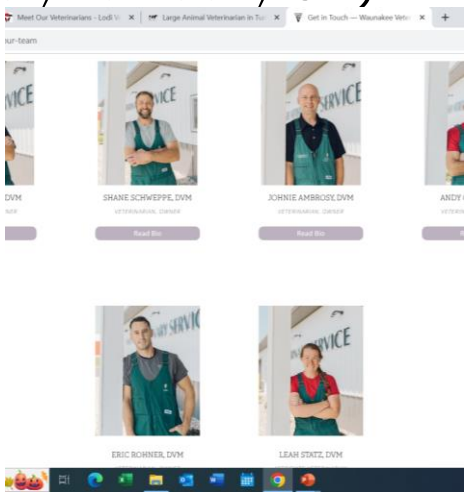
Dr. Brandon Debbink (Dairy Doctors, Plymouth, WI)



Dr. Kendra Wells – Phernetton (Valley Vets, Seymour, WI)

Dr. Blaine Melody (Lander, Turlock, CA)





Quick Facebook Poll October 2023…

- 23 respondents (CA, WA, ND, WI, IL, IN, WA, OH, GA, PA, NJ)
  - **39%: > 200 per week (CA, WI, GA)**
  - 4%: 50 – 99 per week
  - 21%: 25 – 49 per week
  - 34%: < 25 per week

200 per week → 10,000 calves/yr.

Charge normal hourly rate
(charge per head when first starting)

Questions that lung ultrasound can answer

1. Incidence (new cases)
2. Prevalence (existing cases)
3. Onset (days of age)
4. Duration of disease
5. Efficacy of metaphylaxis
6. Efficacy of treatment protocols
7. Competency of care givers
8. Targetted metaphylaxis on arrival
9. Diagnosing rib fractures
10. Treatment decisions

#WeanClean™ approach – what do the calves say?

When calves **don't wean clean**, we **failed them not once but twice**

- We let her get pneumonia (many reasons why this happens)
- We didn't treat her effectively (fewer reasons why this happens)

Scan lungs at **4 strategic points** to promote **#WeanClean** philosophy

1. **Start of weaning** – % pneumonia at the start of weaning? Goal: < 15%
2. **Start of treatment** – % score > 3 or < 2 at their first treatment? Goal: < 15%
3. **7-10 d after treatment** – % lesions after first treatment? Goal: < 15%
4. **12x7 scans** – starting at 7d old, scan 12 calves at 7d intervals, find high risk calves for early detection/treatment of subclinical cases

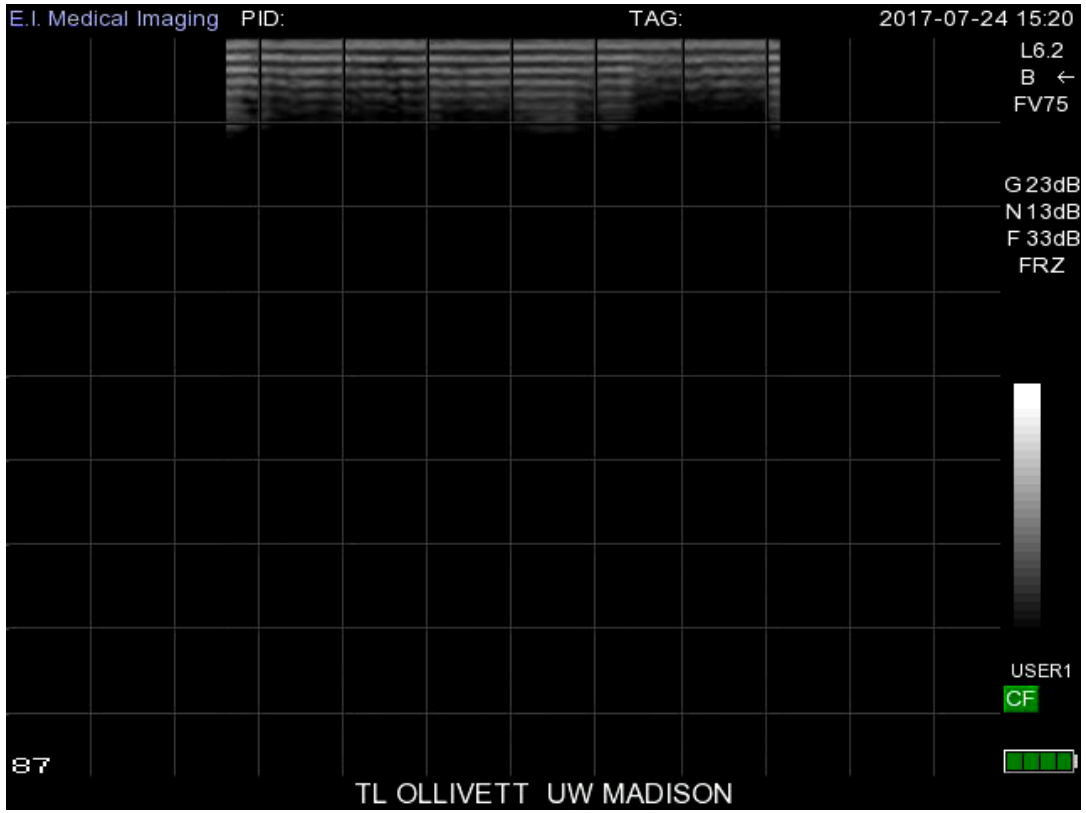
(Ollivett, 2019)

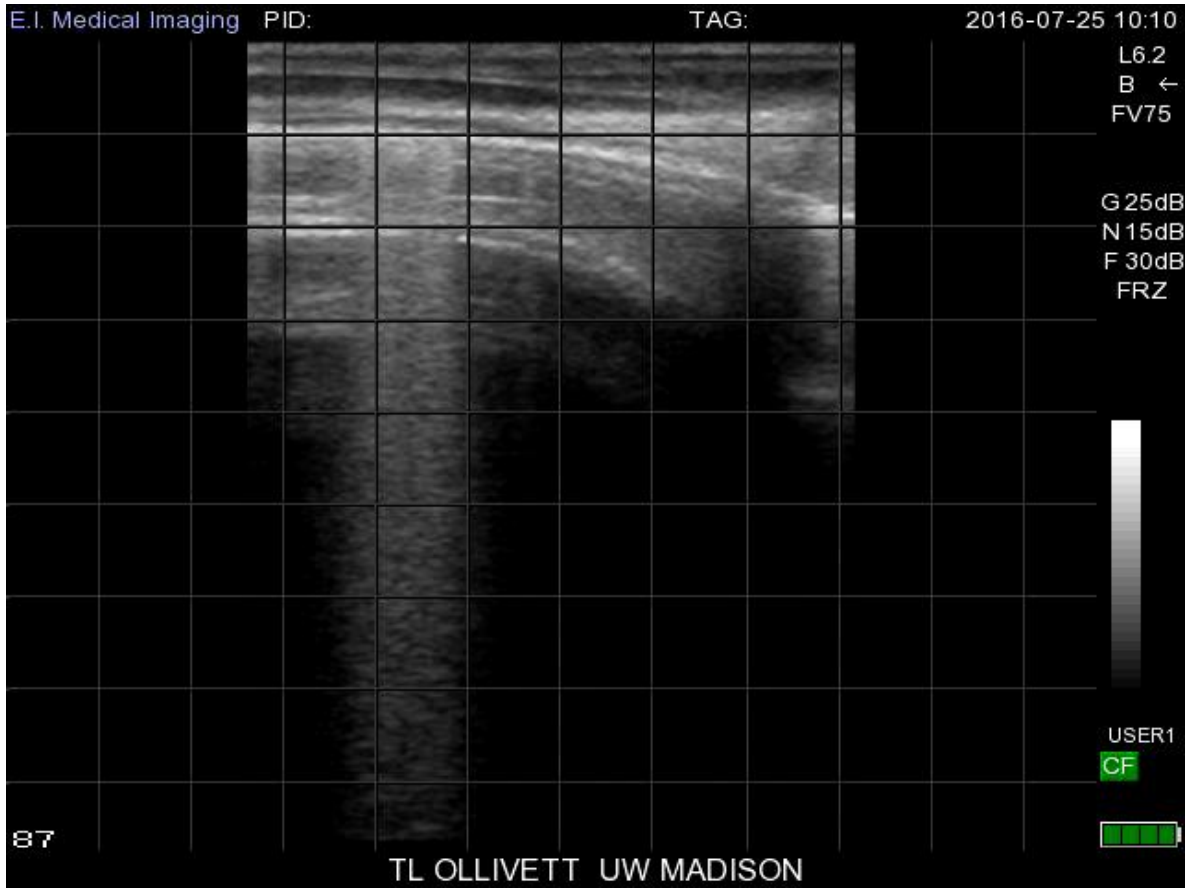
Some observations from the past few years …

- Respiratory bacteria like to do what respiratory bacteria like to do
  - Bronchopneumonia in the right cranial cranial lung lobe
  - Originates at the tracheal bronchus between RCdCr and RCrCr
  - Simmering subclinical disease for a couple weeks before cough starts
  - Endemic disease in 2 – 4 week old calves, high variability from week to week
  - Uncomplicated *Pasteurella multo*cida and *Mycoplasma bovis* don't kill calves

- *E. coli*, *Salmonella* likes to masquerade as respiratory bacteria
  - Septicemia and secondary interstitial lung disease, NOT bronchopneumonia
  - Multiple small subpleural lobular lesions diffusely throughout the lungs that does not distribute preferentially to the RCrCr lobe.
  - Calves are visibly sick (dull, elevated RR, fever, abnormal manure)
  - Calves are dying
  - Overwhelming pathogen load in maternity, hyperosmolar/high total solids MR diet, MR mixing failures

Diffuse subpleural lobular lesions

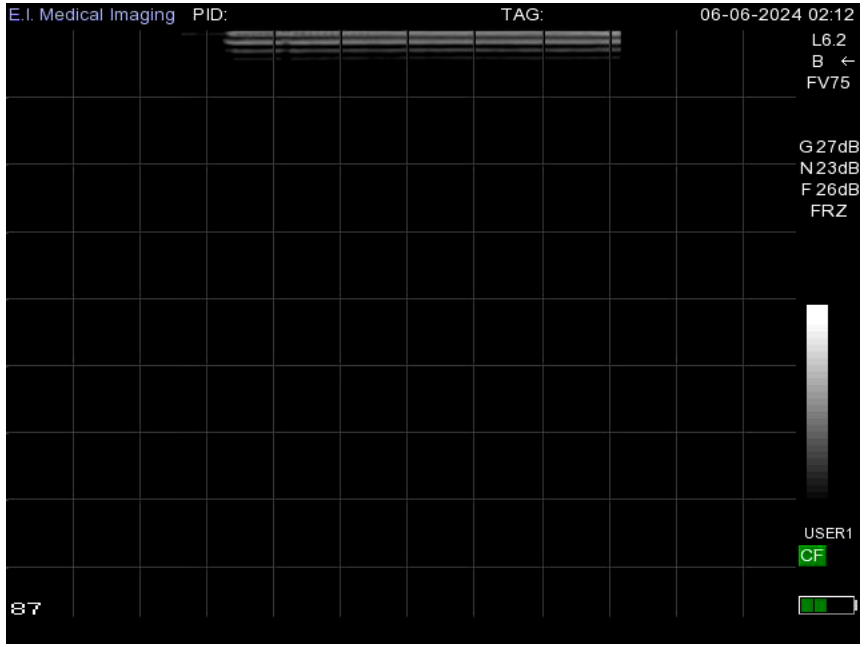


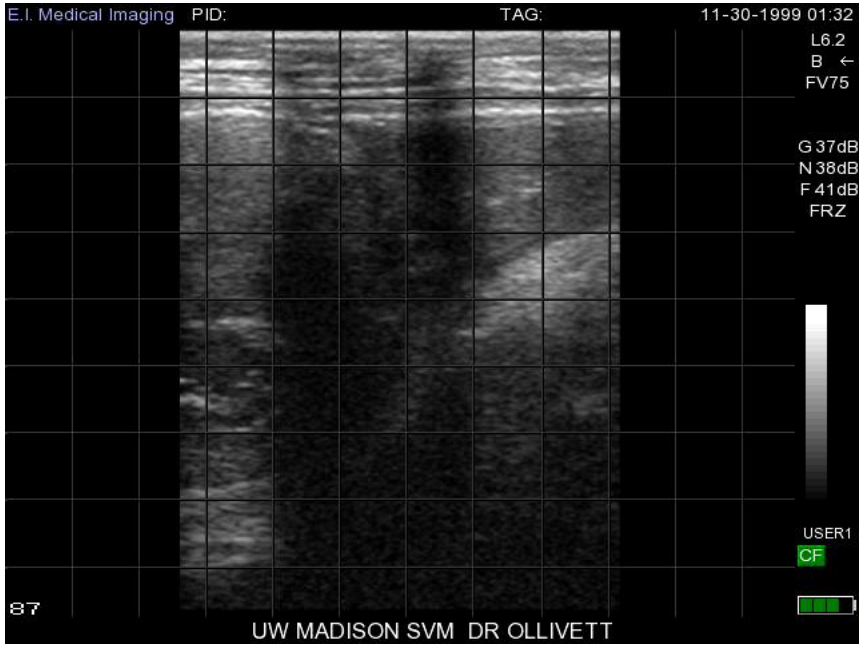


Some clinical observations from the past few years …

- Every lung scan, Every navel, Every calf – get your hands on it
  - Any thickening/discharge/firmness – get your probe on it!
  - Infected internal remnants associated with short, slightly thick external stalks
- Every swollen, painful joint – get your probe on the navel
  - Navel ill more common than Mycoplasma bovis infection
    - It's not the ventilation
    - It's not lack of a vaccine
- Hyperfocusing on "BRD" causes us to miss out on underlying issues, especially septicemia

Internal Navel Infections





Some clinical observations from the past few years …

- Schedule inventory – **slugs of calvings = slugs of sick calves**
- Hygiene, passive transfer, consistent feeding of GI friendly diets trump Vaccine and Antibiotics
- GI upset – huge contributor to lung lesions and poor performance
- People, People, People

HOARD'S DAIRYMAN
VETERINARY COLUMN
by Theresa Ollivett, D.V.M.
School of Veterinary Medicine, University of Wisconsin

Is lung scanning worth the cost?

- Factors to consider
  - Pneumonia events in scanning and post-scanning age calves
  - Overall drug volume used
  - Veterinary fees
  - Mortality
  - Calf value at 180 days
- Real farm data →
  - 2x more PNEU in 10-35 d
  - 5x less PNEU in 36-180 d
  - Mortality 3.6% to 0.5%
  - Weaning weight 160 to 220 lbs.
  - Employees smile more
- Cost-benefit analysis
  - $507 per 100 calves

Year	Raised	Pneu	Died < 180	10-35d Pneu per 100 calves	36-180 d Pneu per 100 calves	Died per 100 calves
2018	1111	1511	36	30	105	3.2
2019	1104	1335	44	24	97	4.0
2020	1031	1170	13	58	54	1.3
2021	975	894	3	59	32	0.3
2022	911	854	5	73	20	0.5

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Key Points:

1. Define your question
2. Subclinical pneumonia:
   - 12x7 scanning for onset age
   - Scan weekly
   - Treat USS2+
   - Record LUNGUS event and lung score

Questions?

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608.358.1640

https://thedairylandinitiative.vetmed.wisc.edu/home/calf-health-module/